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On the pricing of intermediated risks: Theory and application to catastrophe reinsurance ☆

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Abstract

We model the equilibrium price and quantity of risk transfer between firms and financial intermediaries. Value-maximizing firms have downward sloping demands to cede risk, while intermediaries, who assume risk, provide less-than-fully-elastic supply. We show that equilibrium required returns will be "high" in the presence of financing imperfections that make intermediary capital costly. Moreover, financing imperfections can give rise to intermediary market power, so that small changes in financial imperfections can give rise to large changes in price.

We develop tests of this alternative against the null that the supply of intermediary capital is perfectly elastic. We take the US catastrophe reinsurance market as an example, using detailed data from Guy Carpenter & Co., covering a large fraction of the catastrophe risks exchanged during 1970–94. Our results suggest that the price of reinsurance generally exceeds "fair" values, particularly in the aftermath of large events, that market power of reinsurers is not a complete explanation for such pricing, and that reinsurers' high costs of capital appear to play an important role.
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1. Introduction

What drives the prices of intermediated risk transfers? If capital markets were perfect, risks would flow costlessly from corporate hedgers to investors, and required returns would be "fair" in the sense that they would be determined entirely by investor preferences. For example, in a perfect market, firms would pay the riskfree rate to cede risks that are independent of aggregate wealth. In such a world, there would be no need for financial intermediation. Intermediaries, whose job is to distribute, transform, and inventory risk, could add no value. And under perfect markets there would be no rationale for corporate hedging in the first place. As Modigliani-Miller argued, firms would be indifferent between ceding risk (e.g., hedging) and financing risk (e.g., raising equity) at fair prices. So, for example, firms would never cede risks that were independent of aggregate wealth at a rate greater than the riskfree rate.

In practice, of course, markets are far from perfect. These imperfections at once give rise to firms' desire to cede risk and intermediaries' ability to profitably assume risk. For example, investors may be at a competitive disadvantage when it comes to evaluating and monitoring risks that are non-standardized and informationally opaque. If

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forced to finance such risks directly, investors would charge a high rate. A cheaper solution might be for intermediaries to warehouse these risks, with investors financing the intermediaries. Intermediaries can do this and still add value because they provide evaluation and monitoring services. However, although intermediaries may reduce deadweight financing costs, they are unlikely to eliminate them entirely in their own financing needs. Lack of standardization and opacity will continue to be present. As a result, financial intermediation may occur, but the required return on non-standard and opaque intermediated risks will be high. Moreover, intermediaries' capacity for these risks will be less-than-perfectly elastic. In other words, the required return on non-standard and opaque risks that are independent of aggregate wealth will be greater than the riskfree rate and intermediaries will require successively greater returns for bearing additional quantities of such risk.

The industrial structure of intermediation may also be affected by financial imperfections. Bigger intermediaries may conserve on costly external finance because they are better able to diversify risks and fund investment opportunities of a given size. If so, then financing imperfections become a source of increasing returns to scale for intermediaries. Although small financing imperfections can generate only small returns to scale, they can nevertheless generate large increases in market power. The implication is that, under imperfect competition, even small financing imperfections can have large impacts on the equilibrium price of intermediated risk.

In this paper, we model the equilibrium pricing of risks that are non-standardized and opaque. In our view, firms wish to cede risks to economize on financing/investment costs. Because intermediaries specialize in bearing these risks, they can assume them at lower cost than investors, albeit at higher cost than "fair" value. The higher required returns paid by firms ceding these risks are a result of the costs intermediaries bear in funding themselves and the barriers to entry created by the financial imperfections intermediaries face.[1]

Based on these ideas, the model derives a firm's downward-sloping demand for hedging. This demand for hedging is a function of the financing imperfections facing the firm, the amount of financial slack the firm has initially, and the volatility of the risks facing the firm. The model is then used to derive an intermediary's upward-sloping supply of hedging capacity. The intersection of demand and supply is the equilibrium transaction price of intermediated risk. We show that the financing imperfections make the required return on this risk high. It is also clear how the risk profile and financial slack of firms and intermediaries affect conditions equilibrium price and quantity. Finally, we demonstrate how market power of intermediaries can interact with firms' and intermediaries' financing imperfections to raise the cost of hedging intermediated risk even further.

To motivate empirically our model of these issues, we examine one particular market for intermediated risk – that of catastrophe reinsurance. In this market, insurers purchase reinsurance contracts from reinsurers. Under these contracts, reinsurers agree to pay insurer damages resulting from natural perils such as hurricanes and earthquakes. Reinsurers pool these risks in and across their portfolios, but are unable to diversify them fully. This is because potential cat losses are large relative to reinsurer capital.[2] Given the magnitude of potential cat losses, one would expect insurers and reinsurers to hedge cat risk by finding investors with whom to share it. Yet, in fact, insurers and reinsurers tend to retain cat risks. Perhaps because catastrophe risks are neither standardized nor transparent, investors have historically been unwilling to share them directly. As a result, these risks yield high returns and are financed exclusively by insurers and reinsurers – both intermediaries who must find their own costly financing. In other words, the market for catastrophe reinsurance is an intermediated market in which the required return appears high, yet little direct risk transfer to investors occurs.

The market for catastrophe risk is particularly well suited to our analysis because catastrophe exposures are (arguably) independent of the risks on financial assets and because they can be measured using objective scientific models. If cat risks are diversifiable with respect to aggregate wealth, their "fair" required excess return is equal equivalent to the rate of actuarially expected loss. In other words, the total return for bearing diversifiable cat risk exposure should be the riskfree rate. Furthermore, quantitative and objective modeling of the probabilities of catastrophic losses is possible. This means that we can actually calculate the "fair" price of catastrophe reinsurance contracts, and use this to benchmark observed transaction prices. This is the exercise we undertake in the empirical section of this paper. Our benchmark prices come from an extensive set of reinsurance contract data from Guy Carpenter & Co., the largest broker of catastrophe reinsurance worldwide. These transactions data cover a significant fraction of the US catastrophe reinsurance market over the period 1970–1994 and allow us to explore the properties of equilibrium prices and quantities of cat risk transfer.

To preview our empirical findings, the average premiums (i.e., prices) on catastrophe reinsurance are considerably above our estimate of actuarial value. Cat risk, therefore, yields an expected return well in excess of the riskfree rate. Furthermore, we show that prices and quantities are negatively correlated. Both facts suggest that the

[1] Investors more readily bear standardized, transparent exposures, such as major currencies or stock indexes. This reduces the marginal cost of intermediation and the resulting potential for intermediary market power. Consequently, the supply of intermediary capacity will be highly elastic with respect to such risks.

[2] A single catastrophic event (such as a large hurricane or damaging earthquake) can generate potential insured losses of up to $100 billion in the US. Estimates of total capital and surplus of all US insurers is approximately $239 billion; the capital for reinsurers worldwide is estimated at $57 billion. See Froot (1999) for an overview of the market for catastrophe reinsurance.

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